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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/688,021	10/13/2000	Rao Annapragada	LAM1P154	7485

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EXAMINER

ANDERSON, MATTHEW A

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 05/21/2002

5

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/688,021

Applicant(s)

ANNAPRAGADA ET AL.

Examiner

Matthew A. Anderson

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 13 October 2000.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-19 is/are pending in the application.
- 4a) Of the above claim(s) 15-19 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-14 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on _____ is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

DETAILED ACTION

1. Election/Restrictions Restriction to one of the following inventions is required under 35 U.S.C. 121:

- I. Claim 1-14, drawn to process, classified in class 438, subclass 710.
- II. Claims 15-19, drawn to product, classified in class 257, subclass 202

The inventions are distinct, each from the other because of the following reasons:

2. Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product can be formed by a gas etchant of a different chemistry than that of the process.

3. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

4. Because these inventions are distinct for the reasons given above and the search required for Group I is not required for Group II, restriction for examination purposes as indicated is proper.

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5. During a telephone conversation with Michael Lee on 4/29/2002 a provisional election was made with traverse to prosecute the invention of Group I, claims 1-14. Affirmation of this election must be made by applicant in replying to this Office action. Claims 15-19 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

6. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claims 1-5, 7-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Marquez (US 6,228,774 B1) in view of Wolf et al. (Silicon Processing for the VLSI Era, Vol. 1: Process Technology, Lattice Press, Sunset Beach, CA, USA, pp. 539-540, 546-558, 1986.)

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Marquez discloses an etch process for etching a feature in an oxide layer using a plasma. The plasma is disclosed as formed from a gas containing C_4F_8 (aka octafluorocyclobutane), CH_2F_2 (aka difluoromethane), and O_2 in the abstract. Additionally, the addition of a diluent gas to the etchant gas such as Ar (argon) is suggested in lines 30-31 of col. 9. The oxide layer is defined by Marquez in col. 1 lines 24-27 to include the organic oxide TEOS (tetraethylorthosilicate) as well as the oxide glasses of BPSG (borophosphosilicate glass) and PSG (phosphosilicate glass). Marquez discloses an etchstop layer beneath the oxide layer of TiN or refractory metal in the abstract.

Marquez does not disclose the use of CF_4 (aka tetrafluoromethane) as a component of the etchant gas.

Wolf et al. discloses the use of CF_4 as an etchant gas in plasma etching of SiO_2 (aka silicon dioxide) on page 546. Also on that page, the combination of CF_4 and O_2 is disclosed as a etchant of organic solids. On page 550 it is related that the addition of CF_4 can be used to adjust the etching rate by moving the C/F ratio of the etching plasma. Wolf et al. discloses the need for reproducible etch process

It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine the references of Wolf et al. and Marquez and add CF_4 to the fluorine based plasma etching gas described by Marquez because this addition was known to move the etching rate of fluorine based etching gases higher and because such use of CF_4 gas in a plasma etching gas would have been anticipated to produce

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an expected result. The motivation to do so would be the anticipation of higher etch rate and thus higher throughput.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to optimize the etch process generally to improve the uniformity of the etching across the entire wafer, from wafer to wafer, and from run-to-run, (i.e. the RIE lag is low) because such is suggested by Wolf et al. on page 40, the methods of optimizing gas chemistries and process parameters is disclosed on pages 546+, and such optimization would have been anticipated to produce an expected result. The optimization of the F/C ratio is described on page 551.

9. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Marquez and Wolf et al. as applied to claims 1-5, 7-10 above, and further in view of Chiang et al. (US 5739579) and Yonezawa (US 4,161,743).

Marquez combined is described above.

The combination does not suggest the etching through the underlying etchstop layer.

Chiang et al. discloses a method for forming interconnections in devices of multiple levels. Chiang et al. discloses etch stop materials of SiN (silicon nitride and SiC (silicon carbide) and others in col. 14 lines 65+ and in col. 15 lines 1-3 beneath oxide layers of (see col. 13 lines 25-33) spin on glass (i.e. TEOS), PSG, and BPSG.

Yonezawa et al. discloses the patterning of SiC layers with plasma etching of CF₄ and O₂ in col. 3 lines 35-55.

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It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine Marquez combined with Chiang et al. and Yonezawa et al. because Chiang adds known alternative materials for etch stop layers and Yonezawa et al. discloses how to pattern (i.e. etch them). Motivation for the combination is found in that Chiang et al. lists many alternative materials which in turn means greater processing flexibility.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to use a SiC etchstop layer and to etch it with CH₄, O₂, and Ar because Chiang et al. discloses alternate etch stop materials and Yonezawa et al. discloses means of etching SiC. The use of Argon as a diluent in etching gases was suggested by Marquez as above.

10. Claims 11-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Marquez and Wolf et al. as applied to claims 1-5, 7-10 above, and further in view of Chiang et al. (US 5739579) and Hung et al. (US 6,387,287).

Marquez combined is described above.

The combination does not suggest the etching through the underlying etchstop layer.

Chiang et al. discloses a method for forming interconnections in devices of multiple levels. Chiang et al. discloses etch stop materials of SiN (silicon nitride and SiC (silicon carbide) and others in col. 14 lines 65+ and in col. 15 lines 1-3 beneath oxide layers of (see col. 13 lines 25-33) spin on glass (i.e. TEOS), PSG, and BPSG.

Hung et al. discloses an SiN etch using CH₂F₂, O₂ and Ar in Fig. 11.

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It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine Marquez combined with Chiang et al. and Hung et al. because Chiang adds known alternative materials for etch stop layers and Hung et al. discloses how to pattern (i.e. etch them). Motivation for the combination is found in that Chiang et al. lists many alternative materials which in turn means greater processing flexibility.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to use a SiC etchstop layer and to etch it with CH_2F_2 , O_2 , and Ar because Chiang et al. discloses alternate etch stop materials and Hung et al. discloses means of etching SiN.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to stop one gas flow and switch to another gas flow because CH_2F_2 , O_2 and Ar was specifically known in the art as a preferred etchant gas for SiN and its use would have been anticipated to produce an expected result.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to use a consistent gas formulation when again etching oxide because use of the same formulation suggested above will assure consistent results, the use of tailored C/F ratios is suggested by Wolf et al. , and because such use of plasma etching gases would have been anticipated to produce an expected result.

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11. Claims 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Marquez and Wolf et al. as applied to claims 1-5, 7-10 above, Chiang and Hung et al. as applied to claims 11-13 above, and in view of Li et al. (US 6,284,149 B1).

Marquez combined is described above.

The combination does not suggest the stripping a photoresist with the specified etch chemistry.

Li et al. discloses a low dielectric oxide (divinyl siloxane-benocyclobutene). This material is described as a mostly polymer with a small amount of oxide included and is disclosed as an alternative to BPSG. A method of etching in Table 6 second step is shown to include O₂, CH₂F₂, N₂. The second step is described as the for the removal of photoresist and excess low dielectric oxide. In column 19 lines 31-42 it is disclosed that the etchant gases can include Ar if the amount thereof is minimized.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine Marquez combined with Li et al. because Li adds known photoresist removal methods. Motivation for the combination is found in that Li et al. uses the same gases as suggested in other references thus reducing material costs.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to stop one gas flow and switch to another gas flow because a mixture of CH₂F₂ O₂, Ar, and N₂ was specifically known in the art as a preferred etchant gas for photoresist and it use would have been anticipated to produce an expected result.

Claim R jections - 35 USC § 112

12. Claims 1-14 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The phrase "minimal RIE lag" is indefinite in that no guidance is to be found in the specification for the bounds of this limitation.

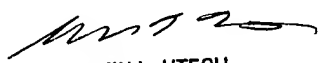
Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew A. Anderson whose telephone number is (703) 308-0086. The examiner can normally be reached on M-Th, 6:30-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin Utech can be reached on (703) 308-3836. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

MAA
May 20, 2002


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